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(19) (CA) APPLICATION FOR CANADIAN PATENT (12)

(54) Doctor Bar for the Volumetric Metering of Flowable
Materials Onto a Travelling Web

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DOCTOR BAR FOR THE VOLUMETRIC METERING OF FLOWABLE
MATERIALS ONTO A TRAVELLING WEB

SPECIFICATION

Field of the Invention

5 Our present invention relates to a doctor bar for the volumetric metering of coating materials, for example, glue or coloring fluids, onto travelling webs, for example, of paper or cardboard. The invention also relates to a coating apparatus using the improved doctor bar as a metering element for the coating material.

Background of the Invention

10 In the coating of travelling paper or cardboard webs, it is known to provide a doctor bar having circumferential grooves defining on the bar, lands separated by the troughs defining the grooves. Such doctor bars are utilized for applying coloring or glue films to the surface of the web or for coating the web with predetermined quantities of the flowable coating agent, the amount of which is
15 influenced by the groove cross section of the doctor bar.

 The doctor bar can be applied directly to the web, if the coating material is applied thereto directly at an upstream location so that the doctor bar serves to control the coating weight per unit area.

20 Alternatively, the doctor bar can function to control the quantity of the coating applied to a coating drum which transfers the coating liquid to the web. In that case, the doctor bar is provided downstream of the applicator in the direction of rotation of the transfer or coating roller or drum.

In that case, the doctor bar is provided downstream of the applicator in the direction of rotation of the transfer or coating roller or drum.

In the case in which a roller or drum is underslung or overslung by the web, the applicator and metering doctor bar can be provided in succession in the path of this roller or web. In the case of another coating system in which the web passes between rollers, one or both of the rollers can form transfer rollers as described and cooperate with applicators and doctor bars for controlling the flowable coating material applied to one or both of the rollers before the roller or rollers transfer the coating material to the web.

Doctor bars of conventional design are found in such applications in German Open Application DE-OS 37 35 889 and in German Utility Model DE-GM 84 14 413. In the first case, the doctor bar cooperates directly with the paper web whereas in the second case the doctor bar serves to control the application of a film to a transfer roller which, in the nip between two rollers, applies the coating material to the web.

It has been found that doctor bars in which the groove arrangement was formed by wrapping a wire around a cylindrical body, suffered from rapid wear. If efforts are made to use rubber coated rollers in conjunction therewith, it is difficult to maintain constant conditions and there is a danger of damage to the roller surface.

In German Patent Document DE-OS 38 41 494 a doctor bar is described which has a multiplicity of button-like protuberances along the surface. These can be fabricated by machining recesses in a cylindrical bar, by etching, milling, grinding, pressing, etc. The protuberances or the entire doctor bar can be composed of low wearing materials, for example, hard materials such as titanium or tungsten, hard chromed steel, glass or oxide ceramic materials.

Notwithstanding the well developed character of this prior art, however, efforts to provide low wearing doctor bars capable of producing stripe-free thin coatings of coating liquids of the type described on travelling webs, especially of

paper or cardboard, have not been fully satisfactory. Furthermore, when the doctor bar was employed for applying coatings to transfer rollers, damage to the transfer roller could not be excluded in many cases.

Objects of the Invention

5 It is, therefore, the principal object of the present invention to provide an improved doctor bar capable of stripe-free application of small-thickness coatings to travelling webs, especially of paper or cardboard, whereby the drawbacks of earlier systems are avoided.

10 Yet another object of the invention is to provide a doctor bar which can be utilized effectively for the application of transferable coatings to a transfer roller without damage to the surface of this roller.

Still another object of the invention is to provide an improved apparatus for coating paper and cardboard webs having an improved doctor bar.

Summary of the Invention

15 These objects and others which will become apparent hereinafter are attained, in accordance with the invention in a doctor bar for volumetric metering of a flowable coating material onto a web, especially a paper or cardboard web, comprising an elongated body formed with a generally cylindrical periphery defined by a surface distribution of discrete rises separated by troughs,

20 the rises having outer faces lying along a cylindrical surface coaxial with the body and being straight in axial cross section;

a total area of the faces constituting 10 % to 50 % of the area of the cylindrical periphery; and

25 a profile depth $P_t(2.5\text{mm})$ of the cylindrical periphery being between $30\text{ }\mu\text{m}$ and $150\text{ }\mu\text{m}$ according to German Industrial Standard DIN 4771.

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According to a feature of the invention each of the rises has flanks extending from the respective outer face to a floor of an adjacent trough, said flanks having a roughness depth R_t which is a maximum of 10 % of the profile depth P_t (2.5mm).

- 5 Preferably the geometric dimensions and distributions of the rises varies along the cylindrical periphery randomly within predetermined limits.

According to a feature of the invention, the rises are generally elongated in a circumferential direction of the body, have widths b of substantially $10\text{ }\mu\text{m}$ to $100\text{ }\mu\text{m}$, and have spacings of substantially $150\text{ }\mu\text{m}$ to $400\text{ }\mu\text{m}$ from one
10 another.

The rises can have widths b randomly varying between substantially $10\text{ }\mu\text{m}$ and substantially $100\text{ }\mu\text{m}$, and spacings randomly varying between substantially $150\text{ }\mu\text{m}$ to substantially $400\text{ }\mu\text{m}$ from one another.

- The lengths of the rises extending in the circumferential direction can be
15 between substantially 1mm and 15mm.

Advantageously, the troughs define in a central longitudinal section through the doctor bar, an open cross sectional area between the rises on one side of the bar amounting to 15 mm^2 to 80 mm^2 per meter of the length of the bar.

- According to another feature of the invention, the rises, which are formed
20 unitarily in the body by laser beam removal of material from a smooth-surfaced cylindrical blank, preferably in a wear-resistant ceramic coating of the blank, are elongated generally circumferentially and have longitudinal extents or dimensions (axes) inclined at an angle α to the circumferential direction of a maximum of 10° .

- 25 According to another aspect of the invention an apparatus for coating a web of paper or cardboard comprises:
two pressing rollers passing the web between them;

applicator means for applying to at least one of the rollers a flowable coating material; and

along the one of the rollers downstream of the applicator means in a direction of rotation of the one of the rollers, a doctor bar for volumetric

5 metering of the flowable coating material onto one of the rollers and by the one of the rollers onto the web and comprising an elongated body formed with a generally cylindrical periphery defined by a surface distribution of discrete rises separated by troughs,

10 the rises having outer faces lying along a cylindrical surface coaxial with the body and being straight in axial cross section,

a total area of the faces constituting 10 % to 50 % of the area of the cylindrical periphery, and

a profile depth $P_t(2.5\text{mm})$ of the cylindrical periphery being between 30 μm and 150 μm according to German Industrial Standard DIN 4771.

15 Alternatively, the apparatus can comprise:

a counter roll around a portion of which the web is slung;

applicator means along this portion for applying to the web a flowable coating material; and

20 along the portion downstream of the applicator means in a direction of rotation of the counter roll and in a direction of advance of the web, a doctor bar for volumetric metering of the flowable coating material onto the web and comprising an elongated body formed with a generally cylindrical periphery defined by a surface distribution of discrete rises separated by troughs,

25 the rises having outer faces lying along a cylindrical surface coaxial with the body and being straight in axial cross section,

a total area of the faces constituting 10 % to 50 % of the area of the cylindrical periphery, and

a profile depth $P_t(2.5\text{mm})$ of the cylindrical periphery being between 30 μm and 150 μm according to German Industrial Standard DIN 4771.

Brief Description of the Drawing

The above and other objects, features and advantages of my invention will
5 become more readily apparent from the following description, reference being made to the accompanying highly diagrammatic drawing in which:

FIG. 1 is a partially broken away diagrammatically elevational view of a doctor bar according to the invention;

FIG. 2 is a diagrammatic section of one apparatus using the doctor bar of the
10 invention for coating a paper or cardboard web;

FIG. 3 is a view similar to FIG. 2 of another apparatus for coating the paper or cardboard web;

FIG. 4 is a fragmentary section through a doctor bar of the invention drawn to a larger scale than FIG. 1; and

15 FIG. 5 is a partial elevational view of the doctor bar of FIG. 4, also drawn to a substantially larger scale than FIG. 1.

Specific Description

The doctor bar illustrated in FIG. 1 comprises a generally cylindrical body 1 which originally was a smooth-surfaced cylinder and in which the entire periphery
20 has been subjected to a material-removal operation, e.g. a laser beam machining operation, to form recesses 3 therein defining a multiplicity of generally elongated but otherwise randomly spaced rises 4 in an array extending over the entire surface of the doctor bar. The faces of the rises 2 are smooth and in an axial cross section are flat, and lie in an imaginary surface of a cylinder C seen
25 in FIG. 4 as well, coaxial with the body, i.e. having the common axis A (FIG. 1) therewith.

As can be seen from FIG. 4, the body 1 may be composed of a steel cylindrical rod 4 coated with a layer 5 of oxide ceramic which then has its cylindrical periphery polished. The grooves 3 are then formed in the surface of the oxide ceramic in such manner that the coating material which is removed from the grooved region is vaporized in a residue-free and burr-free manner. This provides an especially wear-resistant and smooth-surface array of rises.

Alternatively, bars with hardened and polished metal surfaces can be used in which the recesses are formed by means of diametric tools or by etching. Instead of a material removal process the surface can be formed by a pressing operation or embossing to form the rises or by applying material to the bar to constitute the rises which are then ground and polished to be sure that the faces of the rises lie in a common imaginary cylindrical surface.

The doctor bar shown in FIG. 1 can have a diameter of 6mm to 20mm and a length corresponding to the working width of the coating device, i.e. possibly the full machine width, i.e. a length up to 10m.

The sum total of the area of the faces of the rises, i.e. the area which is the coating of the web contacts the web or a transfer roller, preferably constitutes 10% to 50% of the area of the imaginary cylindrical surface. In terms of area, therefore, 50% to 90% of the original surface of the doctor bar will be removed. For a uniform and sufficiently high degree of coating, the surface is so machined that it has a profile depth $P_t(2.5\text{mm})$ according to German Industrial Standard DIN 4771 which is between $30\mu\text{m}$ and $150\mu\text{m}$ as measured in the axial direction of the doctor bar. Within this range there is only a slight variance in the profile depth. The deviation of individual profile depth measurements from the main profile depth can amount to a maximum of 5%.

A high degree of transfer to the coating material from the doctor blade to the web or transfer roller can be achieved when the surface roughness R_t of the flanks of the recesses or rises is less than 10% of the value of the $P_t(2.5\text{mm})$.

In that case there is little hangup of the coating liquid in the recesses between the rises.

Advantageously, as noted, the rises are elongated in outline and have their long dimensions extending generally circumferentially. Preferably the lengths L in the circumferential direction is between 1mm and 15mm while the width b of the rises in the axial direction is between $10\mu\text{m}$ and $100\mu\text{m}$. In some cases, a rise can extend around the entire periphery. The spacing a of the rises from one another preferably amounts to between $150\mu\text{m}$ and $400\mu\text{m}$.

For a uniform coating it has been found to be advantageous to have the geometric dimensions and distributions of the rises generally randomly distributed within certain limits. The range of variations for the width b measured in the axial direction can be between $10\mu\text{m}$ and $100\mu\text{m}$ while the range in variation for the spacing a can be between $150\mu\text{m}$ and $400\mu\text{m}$.

For certain applications it has been found to be advantageous to orient the elongated rises and an inclination to the longitudinal axis or the peripheral direction. In the case shown in FIG. 1, for example, the axes of the rises are inclined at angle α to the circumferential direction. The angle α can be a maximum of 10° and may vary randomly within the range of $\pm 10^\circ$.

For the coating of paper or cardboard with coloring materials, for example, it has been found to be advantageous to have the open cross section between rises in a central section of the bar on one side thereof equal to 15mm^2 to 80mm^2 per meter of the doctor bar length.

In FIG. 2 I have shown an apparatus for applying glue or a coloring material to a paper or cardboard web 12 which is fed in the direction of arrow 13 while being slung around a coating drum 10. At an upstream portion of the path of the web, any conventional applicator 14, including a wiper 15 may be provided to transfer the coating liquid to the web so that the web having the coating thereon is fed at 16 to the doctor bar 17. The latter is received in an elastomeric holder

18 on a rigid structure 19 (see German Patent 30 22 955), for example, which illustrates a preferred mode of resiliently mounting the doctor bar.

The excess liquid is removed by the doctor bar so that the coded product 20 has a uniform film of the coating agent.

5 In this embodiment, the doctor bar operates directly upon the paper or cardboard web to meter the coating material onto the latter and the roller 10 constitutes a counter roller which is underslung by the web and in the underslung region has the applicator and the doctor bar spaced apart one after the other in the web travel direction. The doctor bar is elastically mounted. The apparatus of 10 German Patent 30 22 955 can be used here, substituting the doctor bar of the invention for the smooth doctor bar of that patent.

In the system in which the glue or pigmented flowable material is applied indirectly to the web (FIG. 3) the coating device can comprise 2 placing rollers 30 and 36 through the nip of which the paper web 32 is based.

15 Along one or both of these rollers a nozzle or roller applicator can be provided as shown at 33 to deposit the coating material onto the transfer drum 30 as it is rotated in the direction of 31. A doctor bar 34 according to the invention (corresponding to FIG. 1 or FIGS. 4 and 5) mounted in an elastic holder 17 to 19 as described, engages the drum 30 to remove the excess coating liquid 20 therefrom. The doctor bar is driven in counter rotation to the press roller. A coating device of this type is found in DE-GM 84 14 413 and the preferred resilient support for the doctor bar can be that found in German Patent 30 22 955.

WE CLAIM:

1 1. A doctor bar for volumetric metering of a flowable coating material onto a
2 web, especially a paper or cardboard web, comprising an elongated body formed with
3 a generally cylindrical periphery defined by a surface distribution of discrete
4 rises separated by troughs,
5 said rises having outer faces lying along a cylindrical surface coaxial with
6 said body and being straight in axial cross section;
7 a total area of said faces constituting 10 % to 50 % of the area of said
8 cylindrical periphery; and
9 a profile depth $P_t(2.5\text{mm})$ of said cylindrical periphery being between 30
10 μm and 150 μm according to German Industrial Standard DIN 4771.

1 2. The doctor bar defined in claim 1 wherein each of said rises has flanks
2 extending from the respective outer face to a floor of an adjacent trough, said
3 flanks having a roughness depth R_t which is a maximum of 10 % of said profile
4 depth $P_t(2.5\text{mm})$.

1 3. The doctor bar defined in claim 1 wherein the geometric dimensions and
2 distribution of said rises varies along said cylindrical periphery randomly within
3 predetermined limits.

1 4. The doctor bar defined in claim 1 wherein said rises are generally
2 elongated in a circumferential direction of said body, have widths b of
3 substantially 10 μm to 100 μm , and have spacings of substantially 150
4 μm to 400 μm from one another.

1 5. The doctor bar defined in claim 1 wherein said rises have widths b
2 randomly varying between substantially $10\text{ }\mu\text{m}$ and substantially $100\text{ }\mu\text{m}$, and
3 spacings randomly varying between substantially $150\text{ }\mu\text{m}$ to substantially 400
4 μm from one another.

1 6. The doctor bar defined in claim 1 wherein said rises have lengths
2 extending generally circumferentially of said body between substantially 1 mm and
3 15 mm .

1 7. The doctor bar defined in claim 1 wherein said troughs define in a
2 central longitudinal section through said doctor bar, an open cross sectional area
3 between the rises on one side of the bar amounting to 15 mm^2 to 80 mm^2 per
4 meter of the length of said bar.

1 8. The doctor bar defined in claim 1 wherein said rises are elongated
2 generally circumferentially and have longitudinal extents inclined at an angle
3 α to the circumferential direction of a maximum of 10° .

1 9. The doctor bar defined in claim 1 wherein said rises are formed unitarily
2 in said body by removal of material from a smooth-surfaced cylindrical blank.

1 10. The doctor bar defined in claim 9 wherein said rises are formed in a
2 wear-resistant coating of said blank.

1 11. The doctor bar defined in claim 10 wherein said wear-resistant coating of
2 said blank is a ceramic and said rises are formed by laser machining of said
3 troughs in said ceramic.

1 12. An apparatus for coating a web of paper or cardboard, said apparatus
2 comprising:
3 two pressing rollers passing said web between them;
4 applicator means for applying to at least one of said rollers a flowable
5 coating material; and
6 along said one of said rollers downstream of said applicator means in a
7 direction of rotation of said one of said rollers, a doctor bar for volumetric
8 metering of said flowable coating material onto one of said rollers and by said one
9 of said rollers onto said web and comprising an elongated body formed with a
10 generally cylindrical periphery defined by a surface distribution of discrete rises
11 separated by troughs,
12 said rises having outer faces lying along a cylindrical surface coaxial with
13 said body and being straight in axial cross section,
14 a total area of said faces constituting 10 % to 50 % of the area of said
15 cylindrical periphery, and
16 a profile depth $P_t(2.5\text{mm})$ of said cylindrical periphery being between 30
17 μm and 150 μm according to German Industrial Standard DIN 4771.

1 13. The apparatus defined in claim 12 wherein each of said rises has flanks
2 extending from the respective outer face to a floor of an adjacent trough, said
3 flanks having a roughness depth R_t which is a maximum of 10 % of said profile
4 depth $P_t(2.5\text{mm})$.

1 14. The apparatus defined in claim 13 wherein the geometric dimensions and
2 distribution of said rises varies along said cylindrical periphery randomly within
3 predetermined limits.

1 15. The apparatus defined in claim 14 wherein said rises are generally
2 elongated in a circumferential direction of said body, have widths b of
3 substantially $10\text{ }\mu\text{m}$ to $100\text{ }\mu\text{m}$, and have spacings of substantially 150
4 μm to $400\text{ }\mu\text{m}$ from one another.

1 16. An apparatus for coating a web of paper or cardboard, said apparatus
2 comprising:
3 a counter roll around a portion of which said web is slung;
4 applicator means along said portion for applying to said web a flowable
5 coating material; and
6 along said portion downstream of said applicator means in a direction of
7 rotation of said counter roll and in a direction of advance of said web, a doctor
8 bar for volumetric metering of said flowable coating material onto said web and
9 comprising an elongated body formed with a generally cylindrical periphery defined
10 by a surface distribution of discrete rises separated by troughs,
11 said rises having outer faces lying along a cylindrical surface coaxial with
12 said body and being straight in axial cross section,
13 a total area of said faces constituting 10 % to 50 % of the area of said
14 cylindrical periphery, and
15 a profile depth $P_1(2.5\text{mm})$ of said cylindrical periphery being between 30
16 μm and $150\text{ }\mu\text{m}$ according to German Industrial Standard DIN 4771.

1 17. The apparatus defined in claim 16 wherein said rises have widths b
2 randomly varying between substantially $10\text{ }\mu\text{m}$ and substantially $100\text{ }\mu\text{m}$, and
3 spacings randomly varying between substantially $150\text{ }\mu\text{m}$ to substantially 400
4 μm from one another.

1 18. The apparatus defined in claim 17 wherein said rises have lengths
2 extending generally circumferentially of said body between substantially 1 mm and
3 15 mm.

1 19. The apparatus defined in claim 18 wherein said troughs define in a
2 central longitudinal section through said doctor bar, an open cross sectional area
3 between the rises on one side of the bar amounting to 15 mm^2 to 80 mm^2 per
4 meter of the length of said bar.

1 20. The apparatus defined in claim 19 wherein said rises are elongated
2 generally circumferentially and have longitudinal extents inclined at an angle
3 α to the circumferential direction of a maximum of 10° .

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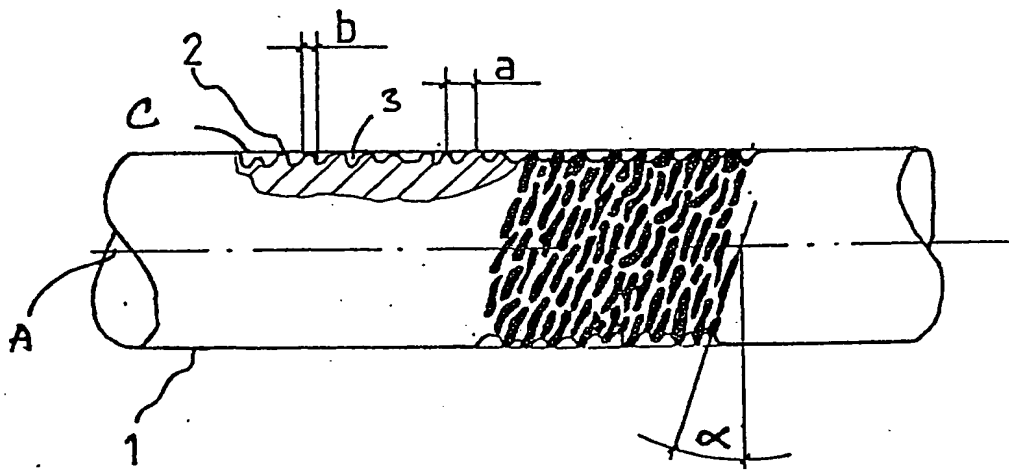
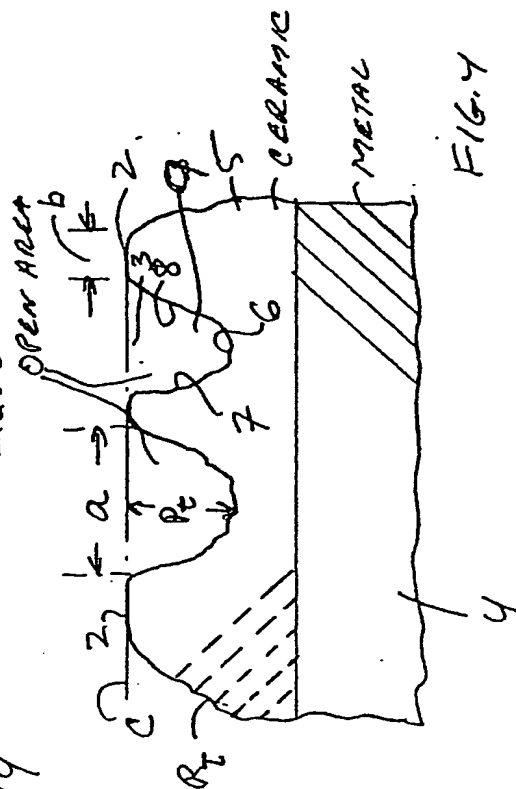
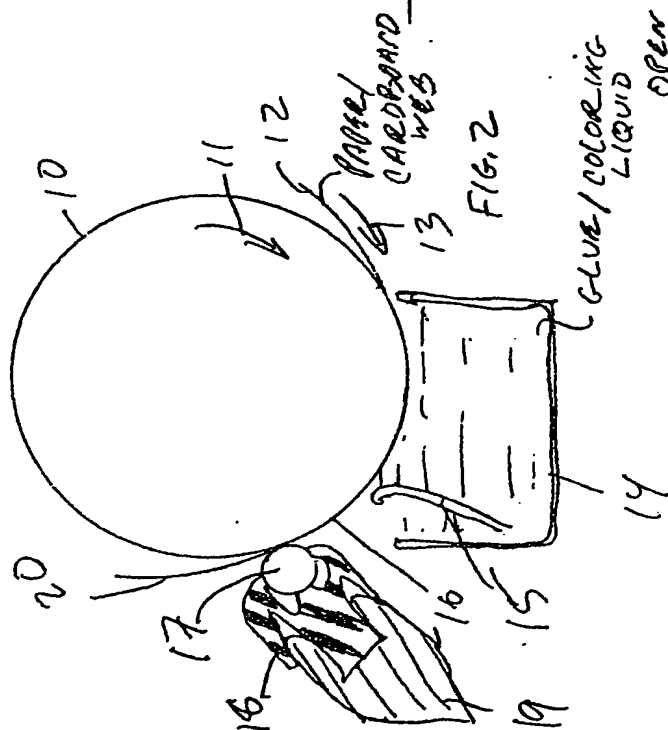
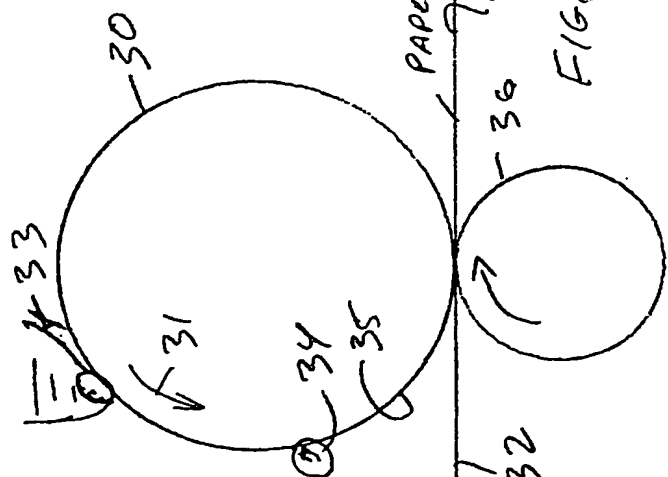


FIG. 1

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ABSTRACT OF THE DISCLOSURE

A doctor bar for volumetric metering of a flowable coating material onto a paper or cardboard web has an elongated body whose generally cylindrical periphery is defined by a surface distribution of discrete rises separated by troughs. The rises have outer faces lying in an imaginary surface coaxial with the body and which are straight in axial cross section. The total area of the faces constitutes 10% to 50% of the area of the cylindrical imaginary surface and the profile depth of the rises is between $30\mu\text{m}$ and $150\mu\text{m}$.

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